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ABSTRACT

Students enrolled in an organic chemistry course were given a diagnostic inventory according to the SCRAPE model. Information was obtained on 11 motivational personality variable and three attitudinal variables for students in both computer-based instruction and regular instruction sections. Descriptive statistics were obtained on each instrument for the two groups, and correlations among variables were examined. Students with higher scores on the academic philosophy of the Orientation Toward College Inventory (OTC) has higher course grades. Abstract conceptualization was found to vary positively with course grade. Higher scores on the task scale of the Bass Orientation Inventory (ORI) were positively related to higher course grades for computer-based instruction while low scores on the task scale had higher grades in the regular instruction group. On the interaction scale of the ORI the high scorers in computer-based classes had lower grades while the high scorers in the regular group had higher grades. In computer-based instruction sections, applied science majors generally tended to have lower course grades, but had more favorable attitudes toward the course and the computer. Copies of the diagnostic inventories are appended. (Author/CH)

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STUDENTS' PERSONALITY, ATTITUDE, AND LEARNING STYLE AS PREDICTORS OF PERFORMANCE IN AN UNDERGRADUATE ORGANIC CHEMISTRY COURSE USING COMPUTER-BASED EDUCATION

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STUDENTS' PERSONALITY, ATTITUDE, AND LEARNING STYLE AS PREDICTORS OF PERFORMANCE IN AN UNDERGRADUATE ORGANIC CHEMISTRY COURSE USING COMPUTER-BASED INSTRUCTION

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ABSTRACT

Various measures were obtained from 72 students enrolled in a two-semester organic chemistry course having two types of sections: computer-based instruction (type C) and regular instruction (type R). The students were divided into five groups according to the type of section in which they were enrolled each semester. Descriptive statistics were obtained on each instrument for each group, and correlations among the variables were examined. Four groups were pooled according to the type of section (R and C) of Chemistry 818b taken in the spring semester. The fifth group was repeating Chemistry 818a; it was under regular instruction. The effects of further division by declared major and by category of major (natural/pure sciences and applied sciences) were also examined.

Differences in course grades appeared to be related to high or low scores on some of the psychological instruments:

1. Higher scorers on the academic philosophy of the Orientation toward College Inventory (OTC) also had higher course grades.

2. The abstract conceptualization (AC) scale of the Learning Style Inventory (LSI) varied positively with course grade.

3. Higher scores on the task scale of the Bass Orientation Inventory (ORI) were positively related to higher course grades for the computer-based education (C-BE) group (Group C), while lower scorers on the task scale had higher grades in the regular instruction group (Group R). On the ORI interaction scale, however, the higher scorers in Group C had lower grades while the higher scorers in Group R had higher grades. Thus, high and low task scorers and high and low interaction scorers made higher grades, depending upon the type (C-BE or regular) of instruction.

4. Attitude data were available only for the group of students which had been in the C-BE sections for both semesters. For the fall data, favorable attitudes toward both the subject matter and computers were associated with lower course grades; spring data did not replicate this relationship. The paper presents reasons why more favorable attitudes toward computers and course are associated with lower grades.

5. In the C-BE sections, applied science majors generally tended to make lower grades, but they generally had more favorable attitudes toward the course and the computer.

An important confounding factor was that course grade reflected other course work as well as computer-related performance. Studies are suggested to further specify and extend the findings on trait-treatment interactions.

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Richard C. Kevin and Paul G. Liberty, Jr.

This paper is the first in a series of reports describing initial efforts to investigate a number of potential predictors of performance in computer-based education courses. Following the general outline of the SCRAPE model (Liberty, 1972), information has been obtained on 11 motivational personality variables and three attitudinal variables for students enrolled in an organic chemistry course (Chemistry 818) during the fall 1972 and spring 1973 semesters.

By relating student scores on these non-cognitive variables to performance in organic chemistry, the investigators hope that they may be able to (a) validate a battery of tests that can predict student performance in computer-based instructional settings and (b) establish norms for those instruments which will allow identification of students who are more and less likely to succeed in various computer-based education (C-BE) courses. More immediately, the present report is an initial evaluative report of variables hypothesized in the SCRAPE model and singled out for investigation by the C-BE Evaluation Committee.

Chemistry 818 is a two-semester introductory organic chemistry course which is taken primarily by chemistry, chemical engineering, and pharmacy majors. During the 1972-73 academic year one section of this course was taught with the assistance of interactive computer-based instructional modules. Students attended two lecture periods per week as well as the traditional laboratory period. The time allotted each week for a third hour of lecture was devoted to the computer modules, which presented basic concepts to the students individually and then allowed students to apply this basic knowledge. A more complete description of the course format, as well as the report of a global evaluation of the course, may be found in Stotter and Culp (1973).

Description of Sample

Data for 72 students enrolled either in Chemistry 818b (N=63) or repeating Chemistry 818a (N=9) in the spring semester 1973 are analyzed in the present study. Forty-three of the 72 students were from a group of 73 students who had been enrolled in the C-BE section of Chemistry 818a in the fall of 1972; nine had failed to complete the fall semester satisfactorily. The remaining 29 students had been enrolled in regular (non-computer-based) sections of Chemistry 818a in the fall of 1972.

The 72 students were divided into five groups based on the types of sections in which they were enrolled in the fall semester of 1972 and the spring semester of 1973. The composition of these groups was as follows:

Group R-C: (N=6) Students who were enrolled in the computer-based (C) section of Chemistry 818b in the spring of 1973, after being in the regular (R) section of Chemistry 818a in the fall of 1972.

Group C-C: (N=22) Students taking Chemistry 818a and 818b in computer-based sections both semesters.

Group C-R: (N=12) Students who had been enrolled in the computer-based section of Chemistry 818a in the fall, but who elected to transfer to a regular section in the spring.

Group R-R: (N=23) Students taking Chemistry 818a and 818b in regular instruction sections both semesters. (Groups C-R and R-R were in the same regular instruction section during the spring semester.)

Group CD-R: (N=9) Students who were enrolled in the computer-based section of Chemistry 818a during the fall semester but who dropped or did not successfully complete the course. This group was repeating Chemistry 818a in a regular instruction section during spring 1973.

For purposes of this study, Groups C-C and R-C, both of which were taking Chemistry 818b during the spring semester, were combined into a Pooled C Group; in text and tables of this report, it will also be called Group C. Likewise, Groups R-R and C-R, both enrolled in Chemistry 818b during the spring semester, were combined into a Pooled R Group, also called Group R. Since the nine students in Group CD-R were repeating Chemistry 818a during the spring semester, they could not be included in the Pooled R Group (Group R) because certain data for them were not available for analysis.

Description of Variables

Information on 23 variables was gathered for students in the five groups specified above. Appendix E includes a list of these variables. A brief state-

ment about each of the variables is presented below.

The Bass Orientation Inventory (ORI) (Bass, 1962) is a psychological test which attempts to measure the types of rewards or satisfactions which individuals prefer. It has been used primarily in investigation of parameters of job and group performance and has been found to predict employee efficiency and satisfaction in some settings. A copy of the ORI is included in Appendix A.

1. The Self Orientation Scale of the ORI indicates the degree to which the individual expects direct personal rewards in his endeavors. A high self score may indicate a concern with status, prestige, and recognition for accomplishments. A high self score may also be correlated with "selfishness" and unresponsiveness to others in a group setting. This scale generally correlates negatively with job performance.

2. The Interaction Orientation Scale of the ORI reflects concern with seeking and maintaining happy and harmonious relationships. An individual who scores high on the interaction scale would be expected to be interested in maintaining a pleasant interpersonal atmosphere, possibly at the expense of effective or efficient performance toward program objectives.

3. The Task Orientation Scale of the ORI is an indicant of the degree to which an individual is concerned with completing a job or effectively dealing with a problem. A highly task-oriented individual would be expected to get primary satisfaction out of getting a job done right and only minimal gratification from recognition of his efforts or the pleasantness of a working group.

The ORI was included in the test battery on the hypothesis that the three dimensions of task, self, and interaction orientation are related to the degree to which an individual is favorably disposed toward and does succeed in computer-based instruction. One of the principal concerns in regard to the educational use of computers has been the effects of the impersonality of computer-based instruction and the absence of humanly-bestowed rewards or approval in the instructional setting. To the extent that some students react negatively to the lack of personal interaction

and rewards which is characteristic of some types of computer-based instruction, the self orientation and interaction orientation scales might be expected to correlate negatively with performance in computer-based education courses. Students who are highly task-oriented would be expected to be less affected by personal recognition and social interaction factors and hence should do better in these same C-BE courses than other students.

The Learning Style Inventory (LSI) (Kolb, Rubin, and McIntyre, 1971) was designed to tap four dimensions of cognitive styles in learning. Each of the dimensions is represented by a characteristic set of adjectives which the subject ranks in terms of their consistency with his personal style for approaching learning tasks. The relative rankings which individuals assign to the adjectives within four-word sets determine their scores on the various dimensions. Higher scores indicate greater reliance upon a given style of learning.

1. The Concrete Experience (CE) dimension is indicated by adjectives such as "receptive," "feeling," and "intuitive." The CE scale seems to indicate a learning style which emphasizes relatively non-analytic contact with the environment.

2. The Reflective Observation (RO) subscale of the LSI includes such adjectives as "tentative," "observing," and "reflecting." It seems that individuals who score high on this scale tend to be detached, uninvolved observers, perhaps more concerned with internal than external stimuli.

3. The Abstract Conceptualization (AC) scale is indicated by the adjectives "analytical," "evaluative," "logical," and "rational." The AC scale appears to be primarily a scholarly or intellectual dimension. Individuals with high AC scores might be expected to be more intellectual, judgmental, and analytic in their approach to learning situations than are high RO or high CE individuals.

4. Active Experimentation (AE), the final LSI scale, is described by the adjectives "practical," "doing," "experimental," and "responsible." AE appears to involve a more active mode of learning. High AE individuals might be expected to be less intellectually oriented than high scorers on the AC dimension, but more actively involved in practical affairs than high AC scorers.

The LSI was included in the test battery because of the possibility that dimensions of learning styles are relevant to success in various modes of computer-based instruction. In a computerized design laboratory, for example, where the speed of the computer allows more trials of alternative procedures than would be possible with conventional techniques, high AE individuals might gain more from the experience than would high RO individuals. Conversely, other computer-based pedagogical techniques which emphasize analysis of process might be found to be of greater benefit to AC individuals. A copy of the LSI is included in Appendix B.

The Orientation toward College Inventory (OTC) (Peterson, 1965) consists of four descriptive statements of personal philosophies which characterize a range of attitudes about the purposes of higher education. Students are asked to rank the philosophies (from 1 to 4) in the order that they reflect the values or motivations that the individual holds in regard to his/her own education endeavors. A lower numerical score thus indicates a higher ranking of the philosophy by the student. The philosophies are:

1. Vocational Philosophy, stressing higher education primarily as career preparation;

2. Academic Philosophy, placing prime emphasis on development of the intellect and a valuation of education as a scholarly endeavor for its own sake;

3. Social Philosophy, stressing extracurricular activities and social life as the principal justification of a college career, while not discounting vocational and academic pursuits; and

4. Identity-seeking Philosophy, stressing the importance of individualism and a search for meaning in life, even if this search challenges existing authority.

The contribution of the OTC is expected to stem from its delineation of four quite widely accepted motivations for pursuing a college career. It is

likely that two individuals espousing opposite philosophies, for example, vocational vs. identity-seeking, might react quite differently when encountering the computer as an instructional device. A copy of the OTC may be found in Appendix C.

Academic Performance in Chemistry includes three elements.

1. Grade-point Average in Chemistry Courses is the mean grade the student has attained in past chemistry courses, including all courses taken during the fall semester of 1972. In the grade-point system at U.T. Austin, A=4, B=3, C=2, D=1, and F=0.

2. Chemistry Placement Scores are the two course grades awarded students in Chemistry 301 and 302, respectively, on the basis of advanced placement examinations at U.T. Austin. Scores on these three variables were available only for chemistry majors (N=17).

3. Chemistry Grades are the grades awarded to students on the basis of their two-semester performances in Chemistry 818. The fall semester grade is for Chemistry 818a in all cases, while the spring semester grade is for Chemistry 818b in the case of all groups except the CD-R group, where the grade was earned in the repetition of Chemistry 818a.

Major Field of Study was the major which each student indicated he/she was pursuing during the 1973 spring semester.

Attitude Measures: The Attitude toward Chemistry Inventory and the Attitude toward the Computer as a Study Aid Inventory each contain 10 items of the bi-polar, semantic differential type. These scales were administered at the end of both the fall and spring semesters to students in Group C-C. A total attitude score was obtained by summing the scores on the two scales. The lower the score on any of the attitude scales, the more positive was the attitude of the student. Specimen copies of the attitude scales are included in Appendix D.

Analysis of Results

Table 1 contains the means and standard deviations of variables for

all groups. Although the data are primarily descriptive, several interesting relationships may be noted.

Bass Orientation Inventory (ORI): Group R-C and Group CD-R students have the highest mean scores on the interaction scale of the ORI and the lowest mean scores on the ORI task scale. Group C-C (the students taking computer-based instruction in both the fall and spring) scored lowest on the ORI interaction scale and highest on the ORI task scale. When comparing C-C and R-C groups, the C-C Group scores higher on self and task, while the R-C group scores higher on interaction. When the C-C and R-C groups are combined in a Pooled C (Computer) Group and compared with the C-R and R-R groups in the Pooled R (Regular Instruction) Group, the C Group is found to be higher on the ORI task scale and lower on the ORI interaction scale than the R Group. Taken together, the results provide support for the hypothesis that students in C-BE sections are more task-motivated and less concerned with affiliative opportunities than students in conventional instruction sections.

Learning Style Inventory (LSI): Inspection of the scores on the LSI scales shows that the AC scale has the highest mean in four of the five groups and the next to highest in the fifth group. All five groups were lowest on the RO scale. This pattern is consistent with the description of the AC scale, which stresses an intellectual or analytic approach to learning. College students, particularly those majoring in scientific fields, might be expected to be analytical. It is notable, however, that the Group C-C students and the Group CD-R students had the highest mean AC scores and that Group R-C had the lowest mean score on the AC scale. These R-C students left a conventional section and entered a computer-based section, in which students possessed the highest average scores in abstract conceptualization. A comparison of the Pooled C Group with the Pooled R Group finds the Computer Group scoring higher on the CE scale and lower on the AE scale; this finding indicates that the Computer Group favors a non-analytic ("feeling, intuitive") hunch-playing approach more than does the Regular Group, while the Regular Group favors a more practical and doing-oriented approach than does the Computer Group.

The Orientation toward College Inventory (OTC): OTC Inventory scores on the four types of educational philosophies provide some interesting contrasts

among the five groups of students. Groups C-C, C-R, and R-R ranked academic and vocational ahead of the social ("extracurricular") philosophy, while Groups R-C and CD-R ranked the social philosophy first. Recall that Groups R-C and CD-R were also highest on the ORI interaction scale. All groups except R-C rated the identity-seeking philosophy as least important; the R-C group ranked the identity-seeking philosophy in a tie for first place with the social philosophy. It is also notable that there is a range of only .45 points in the mean rankings assigned to the four philosophies by Group CD-R and .62 for Group R-C, while the other groups had larger spreads, with the largest spread being 2.17 in the case of Group R-R. The narrower ranges indicate that the average rankings for the various philosophies are closely bunched in the CD-R and R-C groups and that students within the CD-R and R-C groups are quite heterogeneous in regard to their order of preferences.

Lastly, the Pooled R Group is more vocationally-oriented than the Pooled C Group, which ranked the academic orientation ahead of the vocational orientation. There is consistency of results here when it is recalled that the vocational Pooled R Group was also found to be more practical and doing-oriented than the Pooled C Group on the AE scale of the LSI; the Pooled C Group, here favoring an academic orientation, was found to express a greater preference for problem-solving or learning by intuition and hunches (CE scale), which might be seen as a rather important ingredient of an academic, or research, orientation.

Attitudes toward Chemistry and Attitudes toward the Computer as a Study Aid: These attitudes were positive, in general, with a slight increase in favorable attitude (lower mean scores) from fall to spring semesters. The average attitude toward chemistry increased in favor more than did the average attitude toward the computer.

Additional Analyses: Differences between Groups C-C and R-C appeared on the ORI, LSI, OTC, and on spring Grade in Course. The R-C students who transferred into the computer-assisted section were substantially higher on the ORI interaction scale and lower on the task scale. On the LSI, the R-C students were the highest of the five groups on both the CE and RO scales and the lowest on the AC and AE scales. This finding suggests that the R-C Group tended toward more reflective, non-analytic styles; it favored experiential styles of learning as opposed to more intellectual, analytic, and experimental learning styles.

It may also be seen that the C-C Group was the most academically-oriented group on the OTC measure. On the OTC, the R-C students who transferred into the computer-assisted instruction section favored the social and identity-seeking philosophies, while the members of Group C-C favored the academic and vocational philosophies. Finally, the mean spring Grade in Course shows the superior performance of the C-C Group, which averaged 0.62 grade point higher than that of Group R-C.

Overall, the R-C vs. C-C differences in Table 1 seem to indicate that the Group R-C students, who transferred into the computer-based instruction section, were more interaction-minded, more "intuitive," and less academic, less intellectual, and less task-oriented in their learning styles than those who began and remained in the C-BE section (Group C-C). Interestingly, the R-C students showed much poorer academic performance. Some possible explanations for these findings are that the students in Group R-C were changing sections either (a) because of a bad performance in their fall section or (b) because they were seeking an easy out through computer-based instruction for the spring term, or (c) because they hoped to find more interpersonal opportunity than was provided in a disappointing regular course. It is unfortunate that the six transfer students are among those for whom no attitude data are available, since their attitudes toward both the computer and chemistry might have shed further light on their motivation. Fall semester grade data were not collected for the R-C Group.

Comparison of the mean spring Grade in Course for all five groups of students in Table 4 shows a trend which may indicate a beneficial effect of the computer upon student performance. The highest mean grade (2.62) was achieved by students in Group C-C, who had been exposed to computer-assisted instruction for two semesters. The second highest mean score (2.50) was recorded for students in Group C-R, who had one semester (fall) of exposure to the computer modules. The third rank in mean spring performance was occupied by the R-R Group (2.22), which had no experience with computer-based instruction, while the fourth and fifth ranks were occupied respectively by Groups R-C (2.00) and CD-R (0.63).

The fact that the C-R Group performed better than the R-R Group during the spring semester may be due to the operation of a "sleeper" effect of exposure to computer modules in organic chemistry. In other words, the computer

modules may have provided the Group C-R students with a sounder background in organic chemistry or aided them in acquiring more efficient strategies for assimilating the material. Even after their exposure to the computerized material was ended, their performance was superior to that of students who experienced regular instruction for both semesters. It should be noted in this regard that the C-R Group had the highest mean Grade in Course in the fall, but it fell to the second position in the spring semester. When we consider performance as a function of computer-based instruction experience, it thus appears that two semesters of computer-based instruction permitted the Group C-C students to surpass the C-R students, who still attained a higher mean Grade in Course than any of the other groups.

What of the Group R-C students, who performed less well than the students in Group R-R? Their scores on the personality and motivational variables indicate that they differed from the C-C, C-R, and R-R students in ways which may have influenced their performance, but it is also possible that a reverse of the aforementioned "sleeper" effect inhibited their performance. They may have entered the computer-based section of the course with established expectations and strategies for assimilating the material, only to find it necessary to adjust to the structure of the computer-based teaching methods.

Table 2 presents the significant coefficients of correlation between variables, as well as selected non-significant comparisons for all students on whom data were available.[1]

The interaction scale of the ORI correlates negatively with both the LSI AC scale ($r = -.33$) and OTC academic philosophy ($r = -.28$). Academic philosophy also correlates positively with the task scale of the ORI ($r = .40$). Taken together, these comparisons (significant at the .05 level) provide support for the interpretation that the AC scale measures a tendency toward intellectual and analytical rigor, an orientation which is negatively related to a concern for interaction with other persons but positively related to a concern for accomplishing task-oriented objectives. Furthermore, the AC scale correlates significantly at the .05 level with the vocational philosophy.

Because of the small numbers of cases for which these data were available, little can be said about the relationships between Chemistry Placement and GPA

variables and the other variables. Course grades provide a rough measure of performance against which to weigh the predictive validity of the instruments administered. As can be seen in Table 2, spring Grade in Course correlates highly with Chemistry GPA ($r = .64$), Chemistry 301 Placement Test ($r = .71$), and fall Grade in Course ($r = .88$). Such high correlations are to be expected if academic performance is consistent and if the grades are consistently assigned and representative of performance.

It is more noteworthy that social philosophy on the OTC correlates negatively with spring Grade in Course ($r = -.34$, $p < .01$), while the academic philosophy correlates positively with spring Grade in Course ($r = .41$, $p < .01$). The correlations of all other variables with spring Grade in Course are included for inspection. For several other possible predictor-of-performance measures, the small number of cases makes it difficult to assess the true significance of the results, but the correlations suggest that some of the relationships may be high enough to be useful.

Although the correlation coefficients were not statistically significant (i.e., $p > .10$), the self scale of the ORI correlated negatively with both Chemistry GPA ($r = -.45$) and with Chemistry 301 Placement Test ($r = -.38$). Also, the interaction scale correlated positively with the same variables ($r = .37$ and $.51$, respectively). Paradoxically, the task scale related negatively with both Chemistry 301 and Chemistry 302 Placement Test scores ($r = -.35$ and $-.39$, respectively). These possible relationships will be investigated with larger numbers of subjects in subsequent efforts, when information about additional academic performances will be assembled.

The restricted range of some of the test scores may have prevented some potentially relevant relationships from appearing in the correlational analysis. Since the pattern of correlations in Table 2 provided some empirical support for the predictive utility of the battery of instruments, attempts were made to explore further the possible relationships. It was decided to compare the mean spring grades of students who scored higher with those of students who scored lower on selected scales of the various instruments. In this way, it was hoped that relationships not obvious in the correlations (because of low Ns and range-restricted distributions) might become more apparent.

On the AC scale of the LSI and the four philosophies of the OTC, the mean performances of high and low scorers were computed only for the Pooled C Group. Comparisons between high and low scorers on the task orientation and interaction orientation scales of the ORI were made separately for the Pooled C and Pooled R groups. Students in Group CD-R were omitted from this analysis as they were not taking Chemistry 818b in the spring. A summary of the findings is presented in Table 3.

In the case of the LSI, scores on the AC scale were deemed to be highly related to performance in computer-based instruction. This judgment was borne out by the fact that the high-low split on the AC scale generated a difference of 0.53 grade point for Group C students.

On the responses of the OTC, Group C students were broken down into those rating each philosophy as either first or fourth. In the case of the academic philosophy, those students who ranked it first in importance had grades that averaged one full grade-point higher than did the grades of those who rated academic philosophy fourth. In the case of social philosophy, the fourth-ranking group had a 0.75 grade-point advantage over the first-ranking group. Identity-seeking philosophy showed a 0.58 advantage for the low-score (i.e., the fourth-rank) group. Vocational philosophy showed minimal difference between high and low groups.

The results of the high-low split on the task orientation and the interactive orientation scales for Groups C and R present an interesting contrast. In Group C (the students involved in computer-based instruction during the spring semester), a slightly higher mean grade (0.24 higher) was achieved by high task-oriented students. In Group R, however, high task-oriented students scored lower by 0.53 grade point than did the low task-oriented students. The high-low comparisons on the interaction orientation scale show differences in mean performances between Groups C and R that were opposite to those observed in the task orientation comparisons. Group C high interaction students had a lower mean score by 0.51 grade point than did low interaction students. In Group R, on the other hand, the high interaction students achieved a higher mean score than did the low interaction pupils by a margin of 0.21 grade point. These results indicate that computer-based and regular instruction students differ in their "modi operandi"

in organic chemistry. The academic success of students in organic chemistry seems to be determined in some measure by whether they are in C or R sections. High task and low interaction students seem to perform better in computer sections, while low task and high interaction students do better in the regular section. It may be that students with a high task orientation perform better in the more impersonal computer-based instruction setting where there may also be more of work orientation. This high task orientation may not be a plus factor in non-computer-based instruction. Likewise, a high interaction orientation may be a hindrance in computer-based instruction but a positive factor in regular instruction.

In the case of both social and academic philosophies, as well as for the ORI and LSI, the results are in the direction that should be expected from the descriptions of the scales furnished above. This evidence can be taken as preliminary support for the utility of the ORI, LSI, and OTC as predictors of performance in computer-based instruction. Use of various cutting scores will be explored further in a subsequent report.

The analysis of Group C students with regard to attitude variables was necessarily restricted to the C-C subgroup, the only group for which attitude data were available. Table 4 presents the statistically significant ($p<.05$) correlations between attitude scores and other variables. These correlations were generally somewhat surprising. Attitude toward Chemistry (fall) correlated negatively with academic philosophy of the OTC ($r = -.67$), negatively with spring Grade in Course ($r = -.54$), and positively with the social philosophy of the OTC ($r = .50$).

Attitude toward Computers as Study Aid (fall) correlated positively with social philosophy on the OTC ($r = .53$), negatively with both fall and spring Grade in Course ($r = -.54$, $r = -.65$), and positively with fall Attitude toward Chemistry ($r = .60$). The spring attitude variables did not correlate significantly with any of the other variables, except that Total Attitude (spring) correlated 0.57 with Total Attitude (fall).

The correlational findings indicate that a favorable disposition toward both subject matter and computers is negatively related to performance in the course and to an overall academic orientation to college. Among possible

interpretations of these findings, there is the possibility that the poorer students tend to have an unrealistically favorable impression of computer-based instruction. Another possible explanation is that the poorer students are more inclined to "con" the professor by giving a socially desirable, positive response. While this interpretation may not be definitive, consistency is found when one relates these results to those in Table 3. Spring Grade in Course (Table 3) correlates significantly with social and academic philosophies, negatively and positively, respectively. Since the spring Grade in Course correlates negatively with attitude measures, one would expect the attitude measures to show positive correlations with social philosophy and negative correlations with academic philosophy. Instead, the opposite pattern is observed.

The absence of any significant correlations with spring attitude variables might be a joint function of the fact that most of the students had already completed the same questionnaire at the end of the fall semester and the fact that the spring questionnaire was administered early in the semester rather than late, as it was in the fall semester. Given this disparity in times of administration, responses to the spring questionnaire could be indicative of a relative lack of information about new course material and instructional strategies.

To explore further the possible causes of the negative relationship between attitudes and grades, an additional analysis was conducted on the students in Group C-C. The students supplying attitude scores were classified according to major area. Students were divided into two groups: (a) those majoring in applied fields [chemical engineering and pharmacy (N = 6)] and (b) those majoring in the natural sciences [biology, chemistry, and geology (N = 6)]. Two students who listed their majors as pre-med and two who were undetermined majors were excluded from this analysis.

Table 5 presents the means and standard deviations for applied and natural science majors, as well as the results of six single-classification analyses of variance computed to compare the two major groups on each of the attitude scale scores. Table 5 shows that applied majors uniformly reported more positive attitudes toward both computers and chemistry than did the natural science majors. In two instances--Attitude toward the Computer as a Study Aid

(fall) and Total Attitude (fall)--the F values were statistically significant at the .10 level.

Apparently, natural science students (including chemistry majors) paradoxically have a less positive attitude toward the course than do students in the applied fields (chemical engineering and pharmacy), whose majors might be expected to be less enamored of the subject matter. The applied group in the fall semester definitely reported liking the computer more than did the natural science group. The social desirability hypothesis--that applied majors tend to give a positive response which they hope will please the instructor--may account for this difference. Alternatively, it is possible that applied majors are more positively disposed to the computer (because they think it eases their learning task) than are the natural science majors, who are more inclined to study the material for its own sake. A variety of explanations might account for this finding.[2]

To gain more information about the influence of the major subject, the data were further broken down according to the student's declared major. Table 6 presents this breakdown for the Pooled C Group, and Table 7 contains the same information for Groups C-R, R-R, and CD-R combined.

Inspection of the mean fall semester attitude scores in Table 6 shows that the pharmacy majors were primarily responsible for the more favorable responses of the applied major group toward the computer and the course in general. And one may observe that, indeed, applied majors, particularly pharmacy majors, score higher on the social philosophy scale and make lower course grades than do other majors. These are the students who "love" the computer most. Pharmacy students are also the high task scorers who, contrary to most results, make low grades in the course. The applied vs. natural sciences dichotomy seems to warrant further exploration in other evaluation studies, as do the major field classifications of students.

Descriptions of the profiles of scores on the various scales for the various major field groups would be lengthy. To make comparisons more easily understood, Table 8 presents a listing of the majors in the Pooled C Group who scored highest and lowest on each of the scales. Table 9

presents corresponding information for the Pooled R Group plus Group C-DR. Major field groupings with N of less than 3 are excluded from consideration in Tables 8 and 9 to reduce bias from the influence of idiosyncratic responses, but information about the excluded groups can be recovered from the means in Tables 6 and 7.

Pharmacy majors in the Pooled C Group made the highest scores on self orientation and task orientation scales of the ORI, while chemical engineers scored highest on the interaction orientation. Low scorers on self, interaction, and task scales were, respectively, chemistry, biology, and chemical engineering majors. On the LSI, chemical engineering majors scored high on CE and RO scales, while biology majors ranked highest on the AC scale and chemistry students ranked highest on the AE scale. Chemical engineers scored lowest on the AC and AE scales. This latter finding is somewhat surprising, as engineering students in general might be expected to have a more practical, analytical orientation. Chemistry majors were lowest on the CE scale, while biology majors were lowest on the RO scale.

These findings are partially at odds with initial, common-sense hypotheses about how students of different majors would score on the scales. The practically-oriented engineers might be expected to score high on the task scale of the ORI and the AE scale of the LSI. In reality, the opposite trend was observed. What does seem to be indicated is that simple characterizations of the personality types found in various college majors will not be sufficient to account for differences in performance among groupings by major field.

Inspection of Table 9 shows that the trends noted for the Pooled C Group in Table 8 were not consistent with the patterns manifested by Pooled R Group students in conventional classes. Selection procedures for the computer-based instruction class were not elaborate enough to account for these differences. Analysis of larger samples of students with regard to major and the ORI and LSI is needed before conclusions can be drawn. Larger samples of various majors are available in other classes presently being analyzed in conjunction with the instrument-norming effort, and firmer conclusions will have to await reports regarding those classes.

With its broader categories, the OTC provides some information which may be more easily interpreted than that furnished by the ORI and LSI. Table 10

provides a breakdown of the mean rankings awarded to the four personal philosophies by students majoring in chemistry, biology, pharmacy, and chemical engineering within the C and R groups. The chemistry majors and pharmacy majors appear to be most consistent across groups. The chemistry majors favor the academic philosophy over vocational, then social and identity-seeking philosophies in that order, while the pharmacists give greatest weight to the vocational philosophy, make only small discriminations between the social and academic philosophies as second and third choices, and rank identity-seeking last. The chemical engineers are least consistent across groups. The most surprising finding may be that the last choice of Group C is assigned to the academic philosophy; it should be kept in mind, of course, that the data are for only three chemical engineering students in Group C. With their high-ranking concern for personal identity, biology students do not seem to fit easily into either the applied or the natural science group. Again, the small N (3) may be a factor.

In order to obtain a clearer picture of the relationship of the OTC to other variables, an analysis was made of the students in Group C who ranked each of the four philosophies as first choice. As seen in Table 11, students ranking the academic philosophy highest had the highest mean task score on the ORI and the highest mean score on the AC scale of the LSI. Academically-inclined students show an average advantage in course grade over students of the other three orientations. Attitude scores, however, tend to be poorest on the part of the high academic and identity-seeking students. These three findings lend some substance to the hypothesis that socially- and vocationally-oriented students are more positively disposed to the computer than are academically-oriented students because the non-academic students see the computer as a possible short-cut which will make their work easier and more understandable. Academically-oriented students, on the other hand, may be primarily concerned with the subject matter and view the computer merely as one part of the learning process. Since such students usually have considerable abstract conceptual skills, they may have less need for demonstration-teaching offered by the computer.

It is interesting to note in regard to the above hypothesis that the instructor of the Group C class reported a strong negative reaction by the students to the heavy work-load in the course. The issue of what students

expect the computer to do for them is still relatively ill-defined; it is an area calling for more definitive evaluation steps in upcoming semesters.

Variability in the grades made by students with various majors was fairly high (see Tables 6 and 7). With the exception of several groups with small Ns that manifested no change, grades uniformly declined between the fall and spring semesters. All four of the OTC philosophy groups also showed this same decline in mean course grades (Table 11). The decline might be due to a number of causes, but perhaps the most likely explanation lies in the fact that in the spring students' fancies turn to subjects other than organic chemistry.

Finally, Table 12 presents a rank-order summary of the five groups on each of the non-cognitive and performance variables in the study. This type of presentation is intended to provide a comparative overview of each group's scores.

Conclusions

The analyses described in the previous sections focused upon two principal domains of interest: first, the predictive validity of a battery of non-cognitive instruments for identifying students most likely to succeed in computer-based instruction and, second, the ability of these same instruments to discriminate between groups of students classified by college majors, applied vs. natural science, and by five instructional (computer vs. regular) combinations.

The most promising evidence of the predictive validity of the instruments is the difference in students' course grades that appeared to be a function of high or low scores on the various instruments (Table 3). On the social philosophy and the identity-seeking philosophy of the OTC Inventory, high scorers tended to have lower course grades, while high scorers on the academic philosophy manifested higher course grades. The vocational philosophy did not appear to be related to any difference in scholastic performance, although there was a slight trend for students who ranked the vocational philosophy low to perform better.

The AC scale of the LSI was also related to academic performance in Chemistry 818b. Low AC scale scorers performed more poorly on the average

by 0.53 grade point than did the high AC scorers. The results of the high-low split analysis probably indicate that various cutoff scores could be employed to predict academic performance in computer-based and regular instruction sections. A multiple-cutoff selection procedure involving several scales may prove most effective.

Potential for the prediction of differential academic performance between computer-based instruction sections and non-computer-based sections was observed with the task orientation and interaction orientation scales of the orientation inventory. High task orientation students did somewhat better in mean grade than did low task orientation counterparts within Group C, the pooled computer-instruction group. In Group R, however, the low task orientation students performed better on the average. This may be an indication that, as hypothesized initially, high task orientation scorers (with their concern for achieving work goals and their relative unconcern for interpersonal rewards) may be better suited for the individual effort, more impersonal computer-based education setting.

In contrast to the high task orientation scorers, the students who scored high on the interaction orientation scale had poorer grades than low scorers in Group C, but they had somewhat better grades than low interaction students in Group R. Thus, depending upon the type of instruction, high and low task orientation scorers and high and low interaction orientation scorers perform differentially. There is, therefore, an indication that trait-treatment interactions are being revealed by the instruments in the evaluation battery.

Although these findings support the further use of the OTC, the LSI, and particularly the ORI to describe students who enroll in computer-based instruction courses--and even, perhaps, to select those students who are likely to succeed in various settings--two possibly confounding factors in the present investigation must not be overlooked. The first is that the measure of performance employed, course grade, was not a pure performance measure in computer-based instruction. Performance on the computer modules was a factor in the final course grade, but other conventional factors (such as tests over textual material) contributed heavily to the grade each student received. It is thus possible that performance differences, as a function of the ORI scale scores, may actually be due more to the nature of the conventional segments of the

course than to the computer modules. To take this possibly confounding factor into account, future efforts need to employ performance on computer modules alone as a performance measure.

The second problem with the present investigation is that it was not possible to obtain statistically significant differences in performance between the high and low scorers on the psychological scales, given the relatively small Ns available for testing. The purpose of the study was primarily to identify possible leads for further study and to provide a range of evaluative information to decision-makers concerned with the development, implementation, and dissemination of computer-based education projects.

A third issue of concern, the reliability of these instruments, has not been discussed here. Reliability of information is, of course, crucial for any final evaluation of these instruments; estimates of the reliability coefficients of all instruments in use, particularly the LSI, will be obtained both through re-analysis of the present data and future analysis of the results from the larger samples of students to be tested in the 1973 fall semester.

The effects of different college majors were less well-defined than the results of the simple norming, or baseline, efforts with other groups. It does seem clear, however, that college major is a significant factor in attitude toward education and toward the course as measured by the OTC, the Attitude toward Chemistry Inventory and Attitude toward the Computer Inventory. The attitude scales related negatively to academic performance in the computer instruction group, the only group for which attitude data were available. The applied science majors were found to have more favorable attitudes and lower grades than natural science majors.

The fact that the applied majors appear to perform less well in their course work than do the chemistry and biology majors may be an indication that the better students tend to go into "pure" rather than applied fields. Further, it may indicate that a combination of scales, instead of a single scale, may be required to predict academic performance.

Cumulatively, the results suggest that it would be desirable to perform additional data analyses on various scale cutoff scores, as well as other kinds

of analyses that may be desired by the associate investigators.[3] Certainly, additional academic performance data need to be incorporated into the data of this report. Cognitive variables need to be related to the motivational-personality-attitudinal data reported herein and to be included in prediction equations. Continued use of the non-cognitive battery in subsequent semesters seems to be justified by these preliminary results.

FOOTNOTES

1. Most variables were scored or coded in such a way that high scores corresponded to the positive end of each scale. For the OTC and the attitude variables, however, low scores corresponded to the positive end of each scale. To simplify interpretations for the reader, the signs have been reversed on all correlation coefficients involving one variable from the OTC-attitude set and one from the remaining set of variables.

2. One hypothesis offered by Dr. Philip L. Stotter, instructor in the experimental course, is based on his observation that students in the applied fields are accustomed to classes in which a great deal of material must be assimilated through tedious drills. Natural science majors, on the other hand, are usually involved in more stimulating learning experiences where rote learning and drill are minimized. Since organic chemistry is one natural science course which requires that a great deal of material be assimilated in a fairly tedious fashion, students who are majoring in the natural sciences respond relatively negatively because they are not resigned to the boring work required by Chemistry 818. Majors in the applied fields are, however, quite used to tedious classes, and they do not seem to experience the same negative contrast between organic chemistry and their past experience.

3. The associate investigators were Dr. Stotter (see above footnote) and Dr. George H. Culp, who designed the "software" for the project.

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APPENDICES

Appendix A: The Bass Orientation Inventory

Appendix B: The Learning Style Inventory

Appendix C: The Orientation toward College Inventory

Appendix D: The Attitude toward Course Subject Matter Inventory &

The Attitude toward the Computer as an Aid to Mastering Subject Matter Inventory

Appendix E: Tables

Appendix A

THE BASS ORIENTATION INVENTORY*

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BEGIN HERE

1. One of the greatest satisfactions in life is:
   - A Recognition for your efforts.
   - B The feeling of a job well done.
   - C The fun of being with friends.

2. If I played football, I would like to be:
   - A The coach whose planning pays off in victory.
   - B The star quarterback.
   - C Elected captain of the team.

3. The best instructors are those who:
   - A Give you individual help and seem interested in you.
   - B Make a field of study interesting, so you will want to know more about it.
   - C Make the class a friendly group where you feel free to express an opinion.

4. Students downgrade instructors who:
   - A Are sarcastic and seem to take a dislike to certain people.
   - B Make everyone compete with each other.
   - C Simply can't get an idea across and don't seem interested in their subject.

5. I like my friends to:
   - A Want to help others whenever possible.
   - B Be loyal at all times.
   - C Be intelligent and interested in a number of things.

6. My best friends:
   - A Are easy to get along with.
   - B Know more than I do.
   - C Are loyal to me.

7. I would like to be known as:
   - A A successful person.
   - B An efficient person.
   - C A friendly person.

8. If I had my choice, I would like to be:
   - A A research scientist.
   - B A good salesman.
   - C A test pilot.

9. As a youngster I enjoyed:
   - A Just being with the gang.
   - B The feeling of accomplishment I had after I did something well.
   - C Being praised for some achievement.

10. Schools could do a better job if they:
    - A Taught children to follow through on a job.
    - B Encouraged independence and ability in children.
    - C Put less emphasis on competition and more on getting along with others.

11. The trouble with organizations like the Army or Navy is:
    - A The rank system is undemocratic.
    - B The individual gets lost in the organization.
    - C You can never get anything done with all the red tape.

12. If I had more time, I would like to:
    - A Make more friends.
    - B Work at my hobby or learning something new and interesting.
    - C Just take it easy, without any pressure.

13. I think I do my best when:
    - A I work with a group of people who are congenial.
    - B I have a job that is in my line.
    - C My efforts are rewarded.

Open this flap and continue with question 14.

The ORIENTATION INVENTORY

by

Bernard M. Bass, Ph. D.

DIRECTIONS

This test consists of 27 statements of opinions and attitudes. For each statement please indicate in the answer blocks which of the three alternatives, A, B, or C, is *most* true, or *most* preferred, or *most* important to you by writing A, B, or C in the *MOST* column.

Then choose the *least* true or *least* preferred of the three alternatives and write its letter in the *LEAST* column.

For every statement, be sure you mark one alternative in each column. If A is entered under *Most*, then either B or C should be marked under *Least*, and so on.

Do not debate too long over any one statement; your first reaction is desired.

TURN THE SHEET OVER AND BEGIN

(Do not unfold)

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Palo Alto, California

MOST	LEAST	
☐	☐	14. I like: A Being appreciated by others. B Being satisfied personally with my performance. C Being with friends with whom I can have a good time.
☐	☐	15. I would like to see a story about myself in the newspaper: A Describing a project I had completed. B Citing the value of my actions. C Announcing my election to a fraternal organization.
☐	☐	16. I learn best when my instructor: A Provides me with individual attention. B Stimulates me into working harder by arousing my curiosity. C Makes it easy to discuss matters with him and with others.
☐	☐	17. Nothing is worse than: A Having your self-esteem damaged. B Failure on an important task. C Losing your friends.
☐	☐	18. I like: A Personal praise. B Cooperative effort. C Wisdom.
☐	☐	19. I am considerably disturbed by: A Hostile arguments. B Rigidity and refusal to see the value of new ways. C Persons who degrade themselves.
☐	☐	20. I would like to: A Be accepted as a friend by others. B Help others complete a mutual task. C Be admired by others.
☐	☐	21. I like a leader who: A Gets the job done. B Makes himself respected by his followers. C Makes himself easy to talk to.
☐	☐	22. I would like to: A Have a committee meeting to decide what the problem is. B Work out by myself the correct solution to the problem. C Be valued by my boss.
☐	☐	23. Which type of book would you like to read? A A book on getting along with people. B An historical romance. C A how-to-do-it book.
☐	☐	24. Which would you prefer? A Teach pupils how to play the violin. B Play violin solos in concerts. C Write violin concertos.
☐	☐	25. Which leisure time activity is satisfying to you? A Watching westerns on TV. B Chatting with acquaintances. C Keeping busy with interesting hobbies.
☐	☐	26. Which would you prefer, assuming the same amount of money was involved? A Plan a successful contest. B Win a contest. C Advertise the contest and get others to participate.
☐	☐	27. Which is important to you? A To know what you want to do. B To know how to do what you want. C To know how to help others to do what they want.

Name (Please Print):

Last

First *Initial*

Age *Circle Sex:* M F

6 7 8 9 10 11 12 13 14 15 16

Circle Highest School Grade Completed

Current Job:

(If a student, major field of study)

(DO NOT WRITE BELOW THIS LINE)

	M	L	
s			+ 27 =
i			+ 27 =
t			+ 27 =

Standard Scores or Percentiles:
(Circle One)

s
i
t

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Be sure to write your name and supply the other information requested in the space provided above.

Appendix B

THE LEARNING STYLE INVENTORY

LEARNING STYLE INVENTORY

This inventory is designed to assess your method of learning. As you take the inventory, give a high rank to those words which best characterize the way you learn and a low rank to the words which are least characteristic of your learning style.

You may find it hard to choose the words that best describe your learning style because there are no right or wrong answers. Different characteristics described in the inventory are equally good. The aim of the inventory is to describe how you learn, not to evaluate your learning ability.

Instructions

There are nine sets of four words listed below. Rank order each set of four words assigning a 4 to the word which best characterizes your learning style, a 3 to the word which next best characterizes your learning style, a 2 to the next most characteristic word, and a 1 to the word which is least characteristic of you as a learner. Be sure to assign a different rank number to each of the four words in each set. Do not make ties.

1.	____discriminating	____tentative	____involved	____practical
2.	____receptive	____relevant	____analytical	____impartial
3.	____feeling	____watching	____thinking	____doing
4.	____accepting	____risk-taker	____evaluative	____aware
5.	____intuitive	____productive	____logical	____questioning
6.	____abstract	____observing	____concrete	____active
7.	____present-oriented	____reflecting	____future-oriented	____pragmatic
8.	____experience	____observation	____conceptu-alization	____experimentation
9.	____intense	____reserved	____rational	____responsible

FOR SCORING ONLY

CE	RO	AC	AE
234578	136789	234589	136789

Appendix C

THE ORIENTATION TOWARD COLLEGE INVENTORY

NAME _____ AREA OR PROGRAM SPECIALIZATION: _____

ORIENTATION TOWARD COLLEGE

Directions: On every college or university campus, students hold a variety of attitudes about their own purposes and goals while at college. Such an attitude might be thought of as a personal philosophy of higher education. Below are descriptive statements of four such "personal philosophies" which there is reason to believe are quite prevalent on American college campuses. As you read the four statements, attempt to determine how close each comes to your own philosophy of higher education.

_____ PHILOSOPHY A: This philosophy emphasizes education essentially as preparation for an occupational future. Social or purely intellectual phases of campus life are relatively less important, though certainly not ignored. Concern with extracurricular activities and college traditions is relatively small. Persons holding this philosophy are usually quite committed to particular fields of study and are in college primarily to obtain training for careers in their chosen fields.

_____ PHILOSOPHY B: This philosophy, while it does not ignore career preparation, assigns greatest importance to scholarly pursuit of knowledge and understanding wherever the pursuit may lead. This philosophy entails serious involvement in course work or independent study beyond the minimum required. Social life and organized extracurricular activities are relatively unimportant. Thus, while other aspects of college life are not to be forsaken, this philosophy attaches greatest importance to interest in ideas, pursuit of knowledge, and cultivation of the intellect.

_____ PHILOSOPHY C: This philosophy holds that besides occupational training and/or scholarly endeavor, an important part of college life exists outside the classroom, laboratory, and library. Extracurricular activities, living-group functions, are important elements in one's college experience and necessary to the cultivation of the well-rounded person. Thus, while not excluding academic activities, this philosophy emphasizes the importance of the extracurricular side of college life.

_____ PHILOSOPHY D: This is a philosophy held by the student who either consciously rejects commonly held value orientations in favor of his own, or who has not really decided what is to be valued and is, in a sense, searching for meaning in life. There is often deep involvement with ideals and art forms both in the classroom and in sources (often highly original and individualistic) in the wider society. There is little interest in business or professional careers; in fact, there may be a definite rejection of this kind of aspiration. Many facets of the college-organized extracurricular activities, athletics, traditions, the college administration are ignored or viewed with disdain. In short, this philosophy may emphasize individualistic interests and styles, concern for personal identity, and often contempt for many aspects of organized society.

Now that you have read the philosophies, rank the four according to the accuracy with which each portrays your own point of view. Use numbers from 1-4 with one referring to the most appropriate and four to the least appropriate.

Appendix D

THE ATTITUDE TOWARD COURSE SUBJECT MATTER INVENTORY

and

THE ATTITUDE TOWARD THE COMPUTER
AS AN AID TO MASTERING SUBJECT MATTER INVENTORY

Name_____ Date_____

Course Name and Number_____ SS Number___-___-____

For each pair of alternatives circle the number 1 - 7, which indicates where you feel the course material on the computer stands in relation to the two alternatives. This information is being collected for evaluation of the course itself. Your responses will have no effect upon your grade and will be kept strictly confidential.

Course Subject Matter

1.	pleasant	1	2	3	4	5	6	7	unpleasant
2.	chaotic	1	2	3	4	5	6	7	ordered
3.	clear	1	2	3	4	5	6	7	hazy
4.	stale	1	2	3	4	5	6	7	fresh
5.	educational	1	2	3	4	5	6	7	mystifying
6.	attractive	1	2	3	4	5	6	7	repelling
7.	useful	1	2	3	4	5	6	7	useless
8.	lucid	1	2	3	4	5	6	7	obscure
9.	important	1	2	3	4	5	6	7	unimportant
10.	beneficial	1	2	3	4	5	6	7	harmful

The Computer as an Aid to Mastering Subject Matter

11.	good	1	2	3	4	5	6	7	bad
12.	friendly	1	2	3	4	5	6	7	unfriendly
13.	useful	1	2	3	4	5	6	7	useless
14.	successful	1	2	3	4	5	6	7	unsuccessful
15.	educational	1	2	3	4	5	6	7	mystifying
16.	pleasurable	1	2	3	4	5	6	7	painful
17.	skillful	1	2	3	4	5	6	7	bungling
18.	congenial	1	2	3	4	5	6	7	quarrelsome
19.	interesting	1	2	3	4	5	6	7	dull
20.	beneficial	1	2	3	4	5	6	7	harmful

APPENDIX E

TABLES

List of Variables
in Analysis of Organic Chemistry Classes
Tables 1-12

1. Bass Orientation Inventory: Self Scale
2. Bass Orientation Inventory: Interaction Scale
3. Bass Orientation Inventory: Task Scale
4. Learning Style Inventory: Concrete Experience Scale (CE)
5. Learning Style Inventory: Reflective Observation Scale (RO)
6. Learning Style Inventory: Abstract Conceptualization Scale (AC)
7. Learning Style Inventory: Active Experimentation Scale (AE)
8. Orientation toward College Inventory: Vocational Philosophy
9. Orientation toward College Inventory: Academic Philosophy
10. Orientation toward College Inventory: Social Philosophy
11. Orientation toward College Inventory: Identity-Seeking Philosophy
*12. Grade-Point Average in Chemistry Course (as of completion of Fall 1972)
*#13. Chemistry 301 Placement Test
*#14. Chemistry 302 Placement Test
#15. Grade in Chemistry 818a (Fall Semester)
16. Grade in Chemistry 818b (Spring Semester) (Grade for Group CD-R)
17. Student's Major Field
**18. Attitude toward Chemistry Scale, Fall
**19. Attitude toward Computer as a Study Aid Scale, Fall
**20. Total Attitude Score, Fall
**21. Attitude toward Chemistry Scale, Spring
**22. Attitude toward the Computer as a Study Aid Scale, Spring
**23. Total Attitude Score, Spring

*Variables 12-14 were available only for Chemistry majors (N=17).
#Variables 13, 14, and 15 are included in computation of Chemistry GPA.
**Attitude questionnaire was administered only to Group C-C.

Table 1

Means and Standard Deviations of Variables for All Groups
(N=72)

Variables	Group R-C (N=6)			Group C-C (N=22)			Pooled Group C: Groups R-C & C-C Combined (N=28)			Group CD-R (N=9)		
	N	Mean	SD	N	Mean	SD	N	Mean	SD	N	Mean	SD
Bass Orientation Inventory:												
Self	6	22.00	2.83	22	24.45	4.03	28	23.93	4.01	9	22.00	7.97
Interaction	6	29.33	4.11	22	20.36	6.06	28	22.29	6.91	9	26.22	8.80
Task	6	29.83	2.03	22	36.82	6.15	28	35.32	6.34	9	32.78	8.38
Learning Style Inventory:												
Concrete Experience (CE)	6	16.83	2.27	21	14.90	3.26	27	15.33	3.23	9	14.67	2.50
Reflective Observation (RO)	6	14.33	1.37	21	13.62	4.30	27	13.78	3.94	9	12.56	2.92
Abstract Conceptualization (AC)	6	16.50	3.77	21	18.09	4.74	27	17.74	4.68	9	18.89	3.10
Active Experimentation (AE)	6	14.50	3.40	21	15.05	2.82	27	14.93	3.02	9	14.89	3.44
Orientation toward College:												
Vocational Philosophy	6	2.82	1.07	21	2.09	0.99	27	2.25	1.08	9	2.44	1.24
Academic Philosophy	6	2.40	1.02	21	1.90	0.92	27	2.00	0.98	9	2.44	0.88
Social Philosophy	6	2.20	1.46	21	2.71	0.88	27	2.62	1.06	9	2.33	1.12
Identity-Seeking Philosophy	6	2.20	0.75	21	3.24	1.15	27	3.04	1.18	9	2.78	1.39
Chemistry Performance:												
Chemistry GPA				7	2.95	0.72	7	2.95	0.72			
Chemistry 301 Placement Test				5	3.00	0.71	5	3.00	0.71			
Chemistry 302 Placement Test				2	3.00	1.41	2	3.00	1.41			
Chemistry 818a Grade (Fall)				19	2.89	0.81	19	2.89	0.81			
Chemistry 818b Grade (Spring)	3	2.00	0.82	21	2.62	1.04	24	2.54	1.06	8	0.63	1.19
Attitudes, Fall Semester												
Toward Chemistry				15	28.35	5.09	15	28.35	5.09			
Toward Computer				15	28.18	8.13	15	28.18	8.13			
Total				15	56.53	11.91	15	56.53	11.91			
Attitudes, Spring Semester												
Toward Chemistry				15	25.21	5.82	15	25.21	5.82			
Toward Computer				15	26.32	10.01	15	26.32	10.01			
Total				15	51.53	12.51	15	51.53	12.51			

Note.--Lower scores on the OTC and the attitude measures denote more positive values on the respective scales.

Table 1 continued

Variables	Group C-R (N=12)			Group R-R (N=23)			Pooled Group R: Groups C-R & R-R Combined (N=35)			Total Pooled Group: All 5 Groups Combined (N=72)		
	N	Mean	SD	N	Mean	SD	N	Mean	SD	N	Mean	SD
Bass Orientation Inventory:												
Self	12	21.18	6.05	22	24.81	6.81	34	23.58	6.80	71	23.51	5.89
Interaction	12	24.82	3.43	22	22.95	5.55	34	23.48	4.99	71	23.41	6.39
Task	12	35.00	5.90	22	33.24	4.85	34	33.94	5.27	71	34.30	6.12
Learning Style Inventory:												
Concrete Experience (CE)	12	13.67	2.35	23	13.76	2.72	35	13.78	2.57	71	14.48	2.89
Reflective Observation (RO)	12	13.17	3.51	23	13.52	3.41	35	13.44	3.39	71	13.43	3.54
Abstract Conceptualization (AC)	12	17.75	4.67	23	17.52	3.56	35	17.69	3.96	71	17.83	4.12
Active Experimentation (AE)	12	15.83	1.85	23	16.52	2.11	35	16.28	2.05	71	15.57	2.70
Orientation toward College Inventory:												
Vocational Philosophy	12	1.92	1.08	23	1.48	0.79	35	1.62	0.92	71	1.97	1.06
Academic Philosophy	11	1.91	0.94	23	2.39	0.94	34	2.18	0.92	70	2.17	0.95
Social Philosophy	11	2.82	0.98	23	2.48	0.95	34	2.64	0.93	70	2.57	1.01
Identity-Seeking Philosophy	12	3.08	1.16	23	3.65	0.57	35	3.47	0.86	71	3.21	1.08
Chemistry Performance:												
Chemistry GPA	3	3.67	0.28	4	3.66	0.33	7	3.67	0.28	14	3.31	0.65
Chemistry 301 Placement Test	3	2.67	1.15	2	4.00	0.00	5	3.20	1.10	10	3.10	0.88
Chemistry 302 Placement Test				1	3.00	0.00	1	3.00	0.00	3	3.00	1.58
Chemistry 818a Grade (Fall)	10	3.20	0.92	1	3.00	0.00	11	3.18	0.87	30	3.00	0.83
Chemistry 818b Grade (Spring)	12	2.50	1.38	23	2.22	0.95	35	2.38	1.04	17	2.16	1.25
Attitudes, Fall Semester												
Toward Chemistry												
Toward Computer												
Total												
Attitudes, Spring Semester												
Toward Chemistry												
Toward Computer												
Total												

Note.--Lower scores on the OTC and the attitude measures denote more positive values on the respective scales.

Table 2

Selected Correlations between Variables for Organic Chemistry Classes (N=72)

Variables	r	p	N
Interaction vs. LSI AC	-.33	<.01	67
Interaction vs. OTC Academic	-.28	<.05	66
ORI Task vs. OTC Academic	.40	<.01	66
Spring Grade in Course vs. OTC Social	-.34	<.01	65
Spring Grade in Course vs. OTC Academic	.41	<.01	65
Spring Grade in Course vs. Chemistry GPA	.64	<.01	14
Spring Grade in Course vs. Chemistry 301 Placement	.71	<.02	10
Spring Grade in Course vs. Fall Grade in Course	.88	<.01	30
Spring Grade in Course vs. ORI Self	.14	>.10	64
Spring Grade in Course vs. ORI Task	-.21	>.10	64
Spring Grade in Course vs. ORI Interaction	.09	>.10	64
Spring Grade in Course vs. LSI Concrete Experience	-.13	>.10	65
Spring Grade in Course vs. LSI Reflective Observation	-.08	>.10	65
Spring Grade in Course vs. LSI Abstract Conceptualization	.09	>.10	65
Spring Grade in Course vs. LSI Active Experimentation	-.05	>.10	65
Spring Grade in Course vs. OTC Vocational Philosophy	.10	>.10	67
Spring Grade in Course vs. OTC Identity-Seeking Philosophy	-.17	>.10	66
Spring Grade in Course vs. Chemistry 302 Placement	-1.00	>.10	3
LSI AC vs. OTC Vocational	.25	<.05	65
ORI Self vs. Chemistry GPA	-.45	>.10	13
ORI Self vs. Chemistry 301 Placement Test	-.38	>.10	9
ORI Interaction vs. Chemistry GPA	.37	>.10	13
ORI Interaction vs. Chemistry 301 Placement Test	.51	>.10	9
ORI Task vs. Chemistry 301 Placement Test	-.35	>.10	9
ORI Task vs. Chemistry 302 Placement Test	-.39	>.10	4

Note.--As noted in text, lower scores on the OTC and the attitude instruments denote more positive values on the respective scales. This fact resulted in misleading negative correlations between those variables and the other variables. As explained more fully in Footnote 1, the signs were reversed on all such correlation coefficients before they were entered into this and subsequent tables, in order to simplify interpretations of the results.

Table 3

Mean Grades for Group C and Group R Students who Scored High and Low on Selected Scales of the ORI, LSI, and OTC

Instrument	Group	Scale		N[1]	Cutoff Score	Grade
Learning Style Inventory	C	Abstract Conceptual-ization(AC)	Lo	9	≤18	2.22
			Hi	16	≥19	2.75
Orientation toward College Inventory	C	Vocational	Lo	6	4	2.33
			Hi	8	1	2.28
		Academic	Lo	2	4	2.00
			Hi	9	1	3.00
		Social	Lo	5	4	3.00
			Hi	4	1	2.25
		Identity-Seeking	Lo	12	4	2.83
			Hi	4	1	2.25
Orientation Inventory	C	Task	Lo	12	<35	2.33
			Hi	14	≥36	2.57
		Interaction	Lo	15	≤22	2.73
			Hi	9	≥24	2.22
	R	Task	Lo	13	≤32	2.69
			Hi	18	≥33	2.16
		Interaction	Lo	17	≤24	2.29
			Hi	14	≥25	2.50

[1]Ns for high-low comparison in the case of the ORI, the LSI, and the OTC do not equal the respective group Ns because data were unavailable for some students on the selected scales. Also, in the case of the OTC only the extreme rankings were tabulated, and students rating each philosophy as 3s and 2s were not included in the analysis.

Table 4

Correlation of Selected Variables with Attitude Scores
Group C-C
(N=22)

Variables	r	p	N
Attitude toward Chemistry, Fall vs. OTC, Academic	-.67	<.01	17
Attitude toward Chemistry, Fall vs. Grade in Course, Spring	-.54	<.05	16
Attitude toward Chemistry, Fall vs. OTC, Social	.50	<.05	17
Attitude toward Computers as Study Aid, Fall vs. OTC, Social	.53	<.05	17
Attitude toward Computers as Study Aid, Fall vs. Grade in Course, Fall	-.54	<.05	15
Attitude toward Computers as Study Aid, Fall vs. Grade in Course, Spring	-.65	<.01	16
Total Attitude - Spring vs. Total Attitude - Fall	.57	<.02	16
Attitude toward Computers as Study Aid, Fall vs. Attitude toward Chemistry, Fall	.60	<.01	17

Table 5

Mean Attitude Score of Organic Chemistry Students in Group C-C Selected By Two Types of Majors and Results of Analysis of Variance Comparisons (N=12)

Variables	Attitude toward Chemistry				Attitude toward the Computer as a Study Aid				Combined Attitude Scores			
	Fall		Spring		Fall		Spring		Fall		Spring	
	Mean	SD	Mean	SD	Mean	SD	Mean	SD	Mean	SD	Mean	SD
Applied Majors - Chemical Engineering, Pharmacy (N=6)	26.67	6.74	23.17	4.96	23.67	3.72	22.83	5.04	50.33	10.23	46.00	6.51
Natural Science Majors - Chemistry, Biology, and Geology (N=6)	29.67	4.13	25.83	8.33	31.50	7.97	26.17	10.09	61.17	10.26	52.00	17.41
	F=.86 (p >.10)		F=.52 (p>.10)		F=4.76 (p=.05)		F=.60 (p>.10)		F=3.35 (p=.09)		F=.72 (p>.10)	

Note.--Lower scores indicate more positive attitudes.

Table 6

Organic Chemistry Pooled C Group Classified by Majors
(N=28)

Variables		Chemistry	Biology	Geology	Pre-Med	Chem. Eng.	Pharmacy	No Major Listed
Orientation Inventory								
Self	N	8	3	1	2	3	9	2
	Mean	22.75	24.67	16.00	23.50	24.33	25.89	22.50
	SD	1.58	4.73	0.00	0.71	2.52	5.23	4.95
Interaction	N	8	3	1	2	3	9	2
	Mean	24.13	20.67	38.00	22.50	26.33	19.78	14.50
	SD	4.29	6.51	0.00	6.36	4.62	6.79	10.61
Task	N	8	3	1	2	3	9	2
	Mean	34.50	35.67	28.00	35.00	30.33	36.44	44.50
	SD	5.55	10.41	0.00	7.07	2.52	5.62	4.95
Learning Style Inventory								
Concrete Experience (CE)	N	8	3	1	2	3	8	2
	Mean	14.25	14.33	19.00	14.00	16.00	15.75	18.00
	SD	4.53	2.08	0.00	1.41	0.65	2.66	2.83
Reflective Observation (RO)	N	8	3	1	2	3	8	2
	Mean	12.38	14.00	14.00	12.00	17.00	14.12	14.50
	SD	5.04	4.36	0.00	2.83	1.73	0.31	6.36
Abstract Conceptualization (AC)	N	8	3	1	2	3	8	2
	Mean	18.63	20.67	15.00	18.50	15.33	17.63	14.50
	SD	4.60	2.08	0.00	0.50	7.37	3.38	12.02
Active Experimentation (AE)	N	8	3	1	2	3	8	2
	Mean	15.88	14.67	11.00	17.50	13.00	14.63	15.00
	SD	0.44	2.52	0.00	2.12	1.73	0.46	0.00
Orientation toward College Inventory								
Vocational Philosophy	N	8	3	1	2	3	8	2
	Mean	2.38	2.67	3.00	2.50	2.67	1.78	2.00
	SD	1.19	1.53	0.00	2.12	1.53	0.67	0.00

Note.--Lower scores on the OTC scales indicate greater amount of agreement with the philosophy.

Table 6 continued

Variables		Chemistry	Biology	Geology	Pre-Med	Chem. Eng.	Pharmacy	No Major Listed
Academic Philosophy	N	8	3	1	2	3	8	2
	Mean	1.29	2.33	2.00	2.00	3.00	2.38	1.00
	SD	0.49	0.58	0.00	0.00	1.00	1.19	0.00
Social Philsophy	N	8	3	1	2	3	8	2
	Mean	2.86	3.00	4.00	2.00	1.67	2.38	3.50
	SD	0.69	1.00	0.00	1.41	1.15	1.19	0.71
Identity-Seeking Philosophy	N	8	3	1	2	3	8	2
	Mean	3.29	2.00	1.00	3.50	2.67	3.38	3.50
	SD	1.11	1.73	0.00	0.71	1.15	1.06	0.71
Chemistry GPA	N	5	1					1
	Mean	3.21	2.56					2.00
	SD	0.66	0.00					0.00
Chemistry 301 Placement Test	N	4						1
	Mean	3.25						2.00
	SD	0.50						0.00
Chemistry 302 Placement Test	N	2						
	Mean	3.00						
	SD	1.41						
Fall Grade in Course (Chemistry 818a)	N	4	3	0	1	1	8	2
	Mean	3.00	3.00	0.00	4.00	2.00	2.75	3.00
	SD	0.82	1.00	0.00	0.00	0.00	0.71	1.41
Spring Grade in Course (Chemistry 818b)	N	7	3	0	2	2	8	2
	Mean	2.71	3.00	0.00	3.50	1.50	2.25	2.50
	SD	0.95	1.00	0.00	0.71	0.71	1.04	2.12

Note.--Lower scores on the OTC scales indicate greater amount of agreement with the philosophy.

Table 6 continued

	Variables		Chemistry	Biology	Geology	Pre-Med	Chem. Eng.	Pharmacy	No Major Listed
FALL	Attitude toward Chemistry	N	5	1	0	1	1	5	2
		Mean	30.00	28.00	0.00	33.00	31.00	25.80	28.50
		SD	4.53	0.00	0.00	0.00	0.00	7.16	6.36
	Attitude toward Computer	N	5	1	0	1	1	5	2
		Mean	29.40	42.00	0.00	40.00	28.00	22.80	22.50
		SD	6.80	0.00	0.00	0.00	0.00	3.42	12.02
	Total Attitude	N	5	1	0	1	1	5	2
		Mean	59.40	70.00	0.00	73.00	59.00	48.60	51.00
		SD	10.41	0.00	0.00	0.00	0.00	10.41	18.38
SPRING	Attitude toward Chemistry	N	5	1	0	1	1	5	2
		Mean	26.80	21.00	0.00	24.00	19.00	24.00	21.00
		SD	8.07	0.00	0.00	0.00	0.00	5.05	4.24
	Attitude toward Computer	N	5	1	0	1	1	5	2
		Mean	25.40	30.00	0.00	23.00	19.00	23.60	36.50
		SD	10.09	0.00	0.00	0.00	0.00	5.22	27.58
	Total Attitude	N	5	1	0	1	1	5	2
		Mean	52.20	51.00	0.00	47.00	38.00	47.60	57.50
		SD	17.92	0.00	0.00	0.00	0.00	5.81	23.33

Note.--Lower scores indicate more positive attitudes.

Table 7

Organic Chemistry Groups C-R, R-R, CD-R Pooled Classified by Major
(N=44)

Variables		Chemistry	Micro-biology	Zoology	Pharmacy	Chem. Eng.	No Major Listed
Orientation Inventory							
	N	7	1	1	21	10	3
Self	Mean	25.57	20.00	19.00	21.52	26.00	22.33
	SD	6.05	0.00	0.00	6.19	8.96	2.83
	N	7	1	1	21	10	3
Interaction	Mean	19.71	23.00	21.00	26.86	22.00	18.00
	SD	6.29	0.00	0.00	4.84	6.43	12.73
	N	7	1	1	21	10	3
Task	Mean	35.71	38.00	41.00	32.62	33.00	41.00
	SD	4.08	0.00	0.00	6.56	5.96	9.90
Learning Style Inventory							
	N	8	1	1	21	10	3
Concrete Experience (CE)	Mean	12.25	17.00	11.00	14.38	14.00	17.67
	SD	2.38	0.00	0.00	2.13	2.98	0.71
	N	8	1	1	21	10	3
Reflective Observation (RO)	Mean	12.13	13.00	8.00	13.67	13.30	15.33
	SD	2.75	0.00	0.00	3.23	3.74	4.95
	N	8	1	1	21	10	3
Abstract Conceptualization (AC)	Mean	20.50	19.00	21.00	15.95	19.80	14.33
	SD	2.96	0.00	0.00	3.23	3.46	6.36
	N	8	1	1	21	10	3
Active Experimentation (AE)	Mean	15.88	17.00	14.00	16.14	15.50	16.33
	SD	2.59		0.00	2.13	3.06	2.83

Table 7 continued

Variables		Chemistry	Micro-biology	Zoology	Pharmacy	Chem. Eng.	No Major Listed
Orientation toward College Inventory							
Vocational Philosophy	N	8	1	1	21	10	3
	Mean	2.22	3.00	2.00	1.59	1.80	1.67
	SD	1.39	0.00	0.00	0.73	1.23	0.71
Academic Philosophy	N	8	1	1	21	10	2
	Mean	2.00	1.00	1.00	2.52	2.30	1.67
	SD	0.71	0.00	0.00	1.03	0.82	0.71
Social Philosophy	N	8	1	1	21	10	2
	Mean	2.78	4.00	3.00	2.38	2.40	3.00
	SD	0.83	0.00	0.00	1.12	0.84	0.00
Identity-Seeking Philosophy	N	8	1	1	21	10	3
	Mean	3.00	2.00	4.00	3.37	3.50	4.00
	SD	1.32	0.00	0.00	0.90	0.98	0.00
Chemistry GPA	N	5		1	1		
	Mean	3.78		3.33	3.43		
	SD	0.25		0.00	0.00		
Chemistry 301 Placement Test	N	3			1		1
	Mean	2.67			4.00		4.00
	SD	1.15			0.00		0.00
Chemistry 302 Placement Test	N				1		
	Mean				3.00		
	SD				0.00		
Fall Grade, Chemistry 818a	N	3			6	2	
	Mean	3.00			3.50	2.50	
	SD	1.00			0.84	0.71	
Spring Grade, Chemistry 818b	N	8	1	1	21	10	2
	Mean	2.56	1.00	2.00	1.90	1.80	2.00
	SD	0.73	0.00	0.00	1.58	1.14	0.71

Note.--Lower scores on the OTC scales indicate greater amount of agreement with the philosophy.

Table 8

Summary of High and Low Scores
on Variables by Major
in Pooled C Group

Variables	High	Low
Orientation Inventory		
Self	Pharmacy	Chemistry
Interaction	Chem. Eng.	Biology
Task	Pharmacy	Chem. Eng.
Learning Style Inventory		
Concrete Experience (CE)	Chem. Eng.	Chemistry
Reflective Observation (RO)	Chem. Eng.	Biology
Abstract Conceptualization (AC)	Biology	Chem. Eng.
Active Experimentation (AE)	Chemistry	Chem. Eng.
Orientation toward College Inventory		
Vocational Philosophy	Pharmacy	Biology
Academic Philosophy	Chemistry	Chem. Eng.
Social Philosophy	Chem. Eng.	Biology
Identity-Seeking Philosophy	Chemistry	Pharmacy
Grade in Course, Fall*	Biology	Pharmacy
Grade in Course, Spring	Biology	Chem. Eng.
Attitude toward Chemistry, Fall*	Pharmacy	Chemistry
Attitude toward Computer, Fall*	Pharmacy	Biology
Total Attitude, Fall*	Pharmacy	Biology
Attitude toward Chemistry, Spring *	Pharmacy	Chemistry
Attitude toward Computer, Spring*	Pharmacy	Biology
Total Attitude, Spring*	Pharmacy	Chemistry

Note.--Summary includes only those majors represented by three or more students. Therefore, for Table 8, N=23.

*These data were available only for students in Group C-C.

Table 9

Summary of High and Low Scores
Classified by Major
In Pooled R Group plus Group CD-R

Variables	High	Low
Orientation Inventory		
Self	Chem. Eng.	Pharmacy
Interaction	Pharmacy	Chemistry
Task	Chemistry	Pharmacy
Learning Style Inventory		
Concrete Experience (CE)	Pharmacy	Chemistry
Reflective Observation (RO)	Pharmacy	Chemistry
Abstract Conceptualization (AC)	Chemistry	Pharmacy
Active Experimentation (AE)	Pharmacy	Chem. Eng.
Orientation toward College Inventory		
Vocational Philosophy	Pharmacy	Chemistry
Academic Philosophy	Chemistry	Pharmacy
Social Philosophy	Pharmacy	Chemistry
Identity-Seeking Philosophy	Chemistry	Pharmacy
Grade in Course, Fall	Chemistry	Pharmacy
Grade in Course, Spring	Chemistry	Pharmacy

Note.--Summary includes only those majors represented by three or more students. Therefore, for Table 9, N=39.

Table 10

Mean Rankings of Personal Philosophies on OTC by Major and Group

Variables	N	Vocational Philosophy	Academic Philosophy	Social Philosophy	Identity-Seeking Philosophy
Chemistry					
Group C	8	2	1	3	4
Group R with Group CD-R	9	2	1	3	4
Biology					
Group C	3	3	2	4	1
Pharmacy					
Group C	9	1	2.5	2.5	4
Group R with Group CD-R	21	1	3	2	4
Chemical Engineering					
Group C	3	2.5	4	1	2.5
Group R with Group CD-R	10	1	2	3	4

Table 11

Scores on All Variables for Students in Group C Who Gave First Ranking to Each OTC Philosophy (N=28)

Variables		Vocational	Academic	Social	Identity-Seeking
Orientation Inventory					
Self	N	7	10	5	5
	Mean	25.57	24.10	24.80	20.80
	SD	4.16	3.57	4.76	3.49
Interaction	N	7	10	5	5
	Mean	21.57	19.40	25.40	25.40
	SD	5.86	7.46	4.16	8.96
Task	N	7	10	5	5
	Mean	33.86	38.70	31.20	35.00
	SD	6.84	5.91	3.90	7.31
Learning Style Inventory					
Concrete Experience (CE)	N	7	9	5	5
	Mean	15.57	14.33	14.80	16.40
	SD	3.36	4.03	0.84	2.88
Reflective Observation (RO)	N	7	9	5	5
	Mean	13.57	12.89	14.00	15.80
	SD	4.61	4.01	2.45	4.76
Abstract Conceptualization (AC)	N	7	9	5	5
	Mean	16.28	19.56	18.80	17.20
	SD	4.86	5.29	1.30	4.15
Active Experimentation (AE)	N	7	9	5	5
	Mean	15.00	15.00	15.80	12.60
	SD	2.16	3.16	2.86	2.70

Table 11 continued

Variables		Vocational	Academic	Social	Identity-Seeking
Orientation toward College Inventory					
Vocational Philosophy	N	7	10	5	5
	Mean	1.00	2.30	3.00	3.40
	SD	0.00	0.67	1.00	0.55
Academic Philosophy	N	7	10	5	5
	Mean	2.50	1.00	3.00	2.40
	SD	0.55	0.00	0.71	0.89
Social Philosophy	N	7	10	5	5
	Mean	2.50	3.20	1.00	3.20
	SD	0.55	0.79	0.00	0.84
Identity-Seeking Philosophy	N	7	10	5	5
	Mean	4.00	3.50	3.00	1.00
	SD	0.00	0.53	1.00	0.00
Chemistry GPA	N	2	4		1
	Mean	3.12	2.88		2.86
	SD	0.78	0.90		0.00
Chemistry 301 Placement Test	N	1	3		1
	Mean	3.00	3.00		3.00
	SD	0.00	1.00		0.00
Chemistry 302 Placement Test	N		1		1
	Mean		2.00		4.00
	SD		0.00		0.00
Fall Grade in Course	N	7	6	2	4
	Mean	2.71	3.33	3.00	2.50
	SD	0.69	0.82	0.00	1.00
Spring Grade in Course	N	7	6	4	4
	Mean	2.28	3.00	2.25	2.25
	SD	0.88	1.12	0.96	1.26

Note.--Lower scores on the OTC scales indicate greater amount of agreement with the philosophy.

Table 11 continued

Variables			Vocational	Academic	Social	Identity-Seeking
FALL	Attitude toward Chemistry	N	4	6	2	3
		Mean	28.00	31.33	24.50	26.33
		SD	4.96	5.72	2.12	5.69
	Attitude toward Computer	N	4	6	2	3
		Mean	28.00	27.17	23.00	31.67
		SD	8.83	8.61	1.41	10.50
	Total Attitude	N	4	6	2	3
		Mean	56.00	58.50	47.50	58.00
		SD	13.51	13.17	3.54	15.13
SPRING	Attitude toward Chemistry	N	4	6	2	3
		Mean	18.50	25.83	24.50	27.33
		SD	4.04	6.11	0.71	5.51
	Atttidue toward Computer	N	4	6	2	3
		Mean	18.75	30.67	25.50	26.67
		SD	6.13	13.74	4.95	9.45
	Total Attitude	N	4	6	2	3
		Mean	37.25	56.50	50.00	54.00
		SD	9.11	13.20	4.24	9.85

Note.--Lower scores indicate more positive attitudes.

Table 12

Rankings of Mean Scores of Five Organic Chemistry Groups on Non-Cognitive and Performance Variables[1] (N=72)

Variables	R-C	C-C	C-R	R-R	CD-R
Orientation Inventory					
Self	3.5	2	5	1	3.5
Interaction	1	5	3	4	2
Task	5	1	2	3	4
Learning Style Inventory					
Concrete Experience (CE)	1	2	5	4	3
Reflective Observation (RO)	1	2	4	3	5
Abstract Conceptualization (AC)	5	2	4	3	1
Active Experimentation (AE)	5	3	2	1	4
Orientation toward College Inventory					
Vocational Philosophy	5	3	2	1	4
Academic Philosophy	4	1	2	3	5
Social Philosophy	1	4	5	3	2
Identity-Seeking Philosophy	1	4	3	5	2
Chemistry GPA		3	1	2	
Chemistry 301 Placement Test		2	3	1	
Chemistry 302 Placement Test		1		1	
Fall Grade in Course		3	1	2	
Spring Grade in Course	4	1	2	3	5

[1]Mean attitude scores were available for C-C Group only.